

LTC7800EUDC High Frequency Synchronous Buck Converter with GaN Transistors

DESCRIPTION

Demonstration circuit 2736A is a single output high voltage nonisolated synchronous step-down converter that drives all GaN transistor power stage. It features the [LTC[®]7800](#), a low quiescent current high frequency (programmable fixed frequency from 320kHz up to 2.25MHz) synchronous step-down DC/DC controller housed in a small 3mm × 4mm QFN package.

This DC2736A operates over an input voltage range from 30V to 55V, while the LTC7800 can operate up to 60V. This demo board produces a 12V output voltage with up to 20A output current, and is configured with a sense resistor for current sensing. A mode selector allows the DC2736A to operate in forced continuous operation, pulse-skipping or Burst Mode[®] operation during light loads.

The LTC7800 features two integrated 5V gate drivers with 20ns dead time which is good for GaN transistors or logic-level MOSFETs to maximize efficiency. The EXT_{V_{CC}} pin permits the LTC7800 to be powered from the output of the switching regulator or other available source, reducing power dissipation and improving efficiency. Please refer to the LTC7800 data sheet for a complete description of the part operation and application information.

Design files for this circuit board are available at <http://www.linear.com/demo/DC2736A>

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PERFORMANCE SUMMARY Specifications are at T_A = 25°C

| PARAMETER | CONDITIONS | VALUE |
|--|--|------------|
| Input Voltage Range | | 30V to 55V |
| Output Voltage, V _{OUT} | V _{IN} = 30V – 55V, Single Output, I _{OUT} = 0A to 20A | 12V |
| Maximum Output Current, I _{OUT} | V _{IN} = 30V – 55V | 20A |
| Typical Efficiency | V _{IN} = 48V, Single Output, V _{OUT} = 12V, 20A Load | 96% |
| Default Switching Frequency | | 500kHz |

QUICK START PROCEDURE

Demonstration circuit 2736A is easy to set up to evaluate the performance of the LTC7800. Refer to Figure 1 for the proper measurement equipment setup and follow the procedure below.

1. With board not connected, adjust the input power supply to 48V, then turn off the input power supply. Make sure the input power supply is capable of 10A at 30V.
2. With power off, connect the input power supply to V_{IN} and GND terminal of the board.
3. Connect the output load between V_{OUT} and GND (Initial load: no load). Refer to Figure 1.
4. Connect the DVMs to the input and output.
5. Check the default jumper/switch position: JP7: ON; JP13: CCM.
6. Turn on the input power supply.

NOTE: The input voltage range for the board is 30V to 55V.

7. Check for the proper output voltage from V_{OUT} to GND. The output voltage should be between 11.76V to 12.24V.
8. Once the proper output voltage is established, adjust the loads within the operating range (0A to 20A) and observe the output voltage regulation, ripple voltage and other parameters.
9. After completing all tests, adjust the load to 0A, turn off the input power supply.

Notes:

1. When measuring the output or input voltage ripple, do not use the long ground lead on the oscilloscope probe. See Figure 2 for the proper scope probe technique. Short, stiff leads need to be soldered to the (+) and (-) terminals of an output capacitor. The probe's ground ring needs to touch the (-) lead and the probe tip needs to touch the (+) lead.
2. Please set the electronic load in *CR (constant resistance) mode* for the evaluation of the board. The default setup of the 2736A board is to have $EXTV_{CC}$ pin connected to V_{OUT} . Some electronic load outputs negative voltage when doing output overcurrent test of the board, which exceeds the absolute maximum rating $-0.3V$ on $EXTV_{CC}$ pin of LTC7800.

External $EXTV_{CC}$ Option

By default, the $EXTV_{CC}$ pin of LTC7800 on DC2736A board is connected to the output of the converter with R69 (0 Ω) for good efficiency and good thermal performance. Please follow the below procedure if an external power supply is used to bias the LTC7800 $EXTV_{CC}$ pin (Do not float this pin).

1. Remove R69 on the board.
2. Apply a DC voltage (recommend 5.5V – 13V) on $EXTV_{CC}$ and GND turret after the input voltage is established. Make sure $EXTV_{CC} < V_{IN}$.
3. Turn off the DC bias on the $EXTV_{CC}$ before powering off the input power supply.

QUICK START PROCEDURE

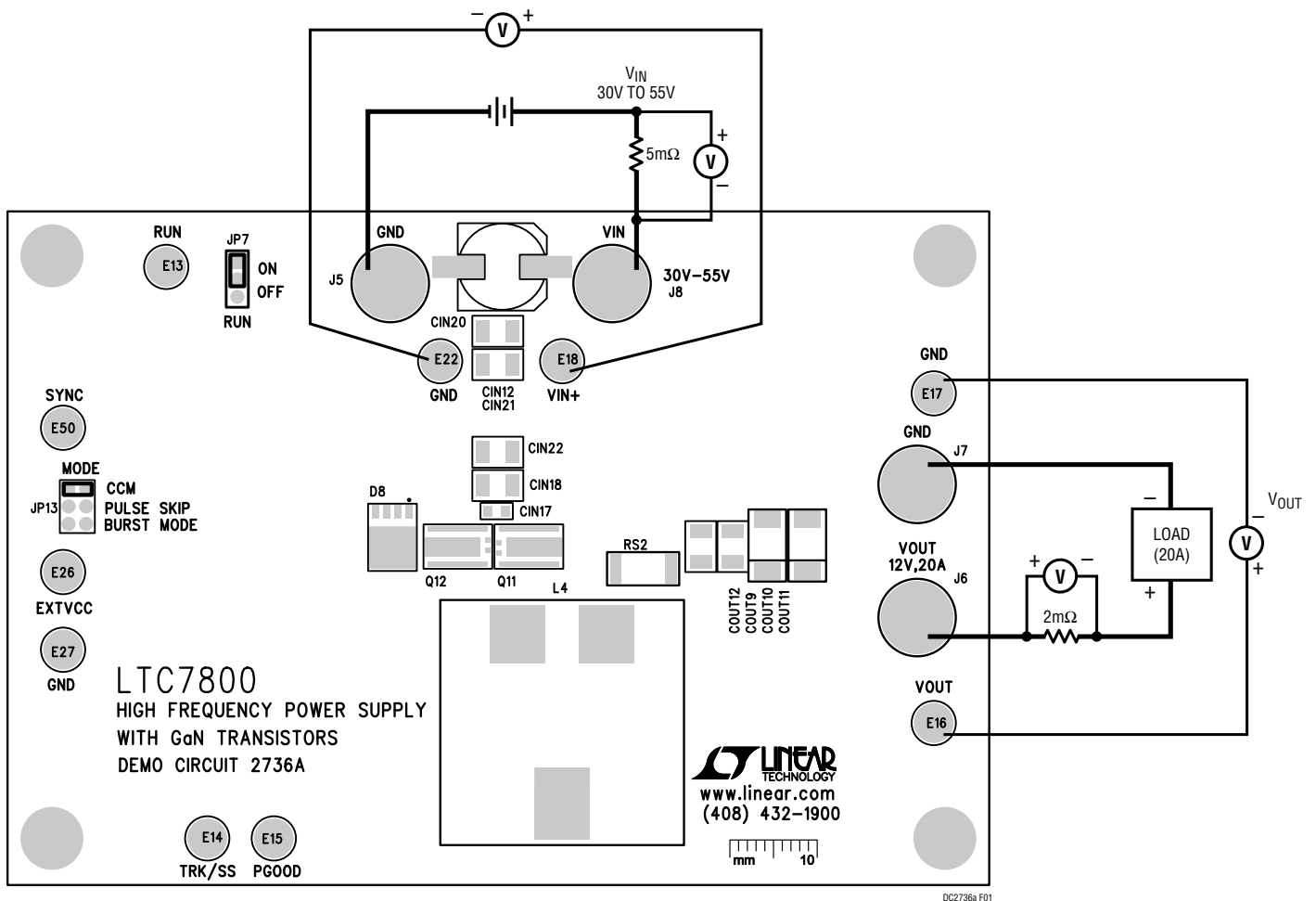


Figure 1. Proper Measurement Equipment Setup

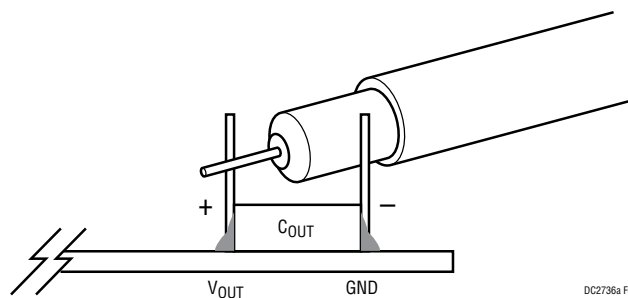


Figure 2. Measuring Output Voltage Ripple

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QUICK START PROCEDURE

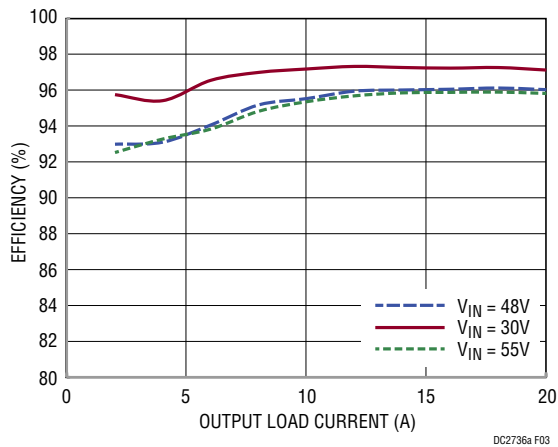


Figure 3. Efficiency vs Load Current at $V_{OUT} = 12V$, $f_{SW} = 500kHz$

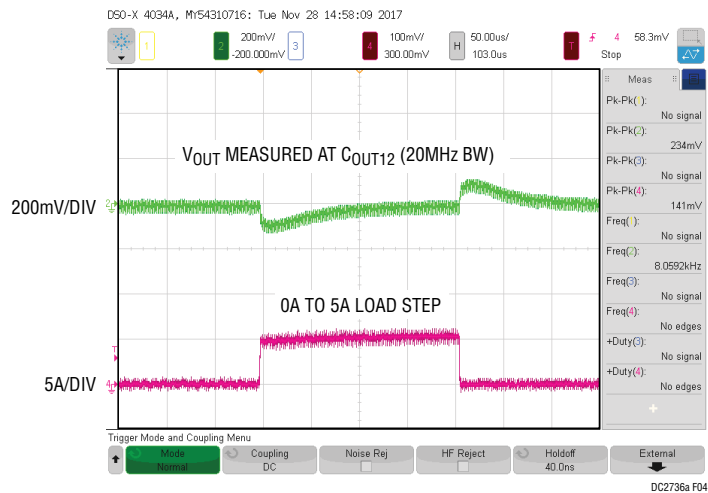


Figure 4. Transient Response at $V_{IN} = 48V$, $V_{OUT} = 12V$, $f_{SW} = 500kHz$

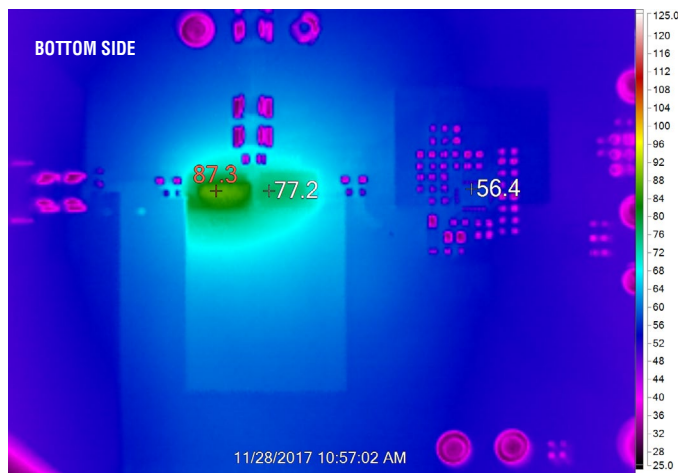
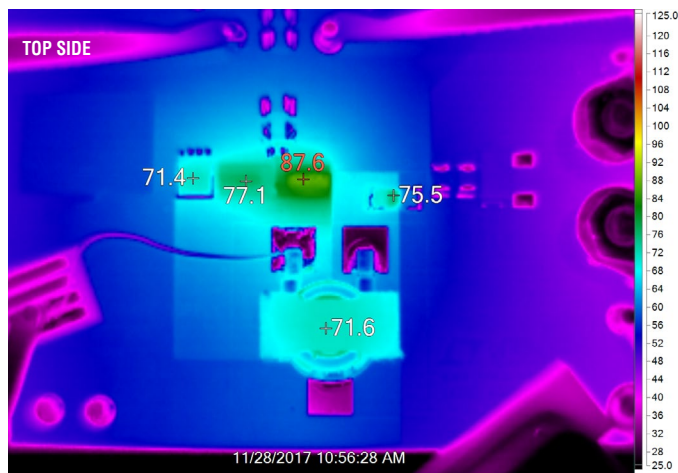


Figure 5. Thermal Performance at $V_{IN} = 48V$, $V_{OUT} = 12V$, $I_{OUT} = 20A$, $T_A = 23^\circ C$, in Free Air

PARTS LIST

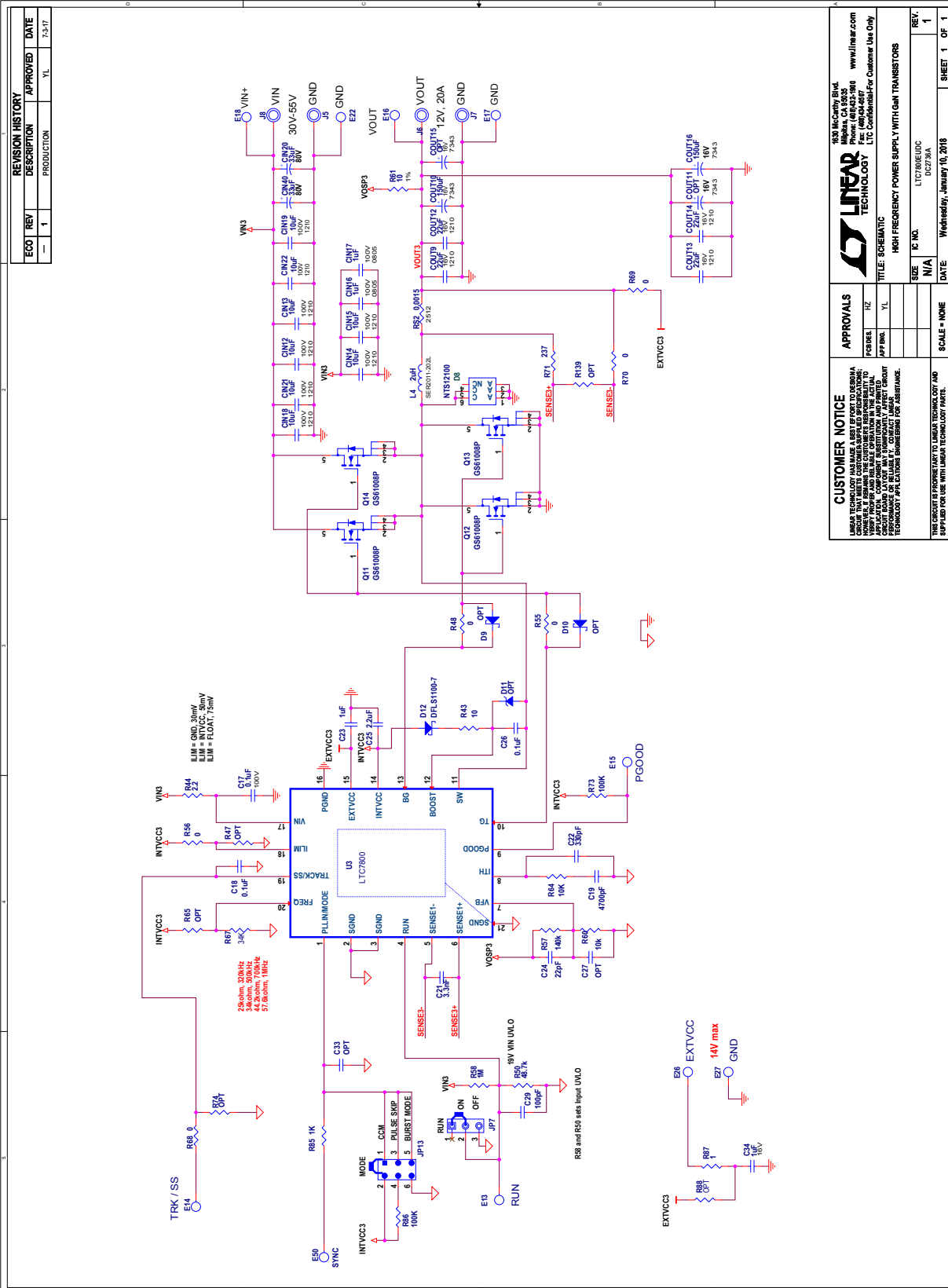
| ITEM | QTY | REFERENCE | PART DESCRIPTION | MANUFACTURER/PART NUMBER |
|------------------------------------|-----|--|--|------------------------------|
| Required Circuit Components | | | | |
| 1 | 8 | CIN12, CIN13, CIN14, CIN15, CIN18, CIN19, CIN21, CIN22 | CAP, 1210 10 μ F 20% 100V X7S | MURATA, GRM32EC72A106K |
| 2 | 2 | CIN16, CIN17 | CAP, 0805 1 μ F 20% 100V X7S | MURATA, GRM21BC72A105KE01L |
| 3 | 2 | CIN20, CIN40 | CAP, 33 μ F 80V 10.3 \times 10.3 | PANASONIC, EEHZA1K330P |
| 4 | 4 | COUT9, COUT12, COUT13, COUT14 | CAP, 1210 22 μ F 10% 16V X7R | TDK, C3225X7R1C226K |
| 5 | 2 | COUT10, COUT16 | FAB, PRINTED CIRCUIT BOARD | PANASONIC, 16TQC150MYF |
| 6 | 3 | C17, C18, C26 | CAP, 0603 0.1 μ F 10% 100V X7R | MURATA, GRM188R72A104KA35D |
| 7 | 1 | C19 | CAP, 0603 4700pF 10% 50V X7R | AVX, 06035C472KAT2A |
| 8 | 1 | C21 | CAP, 0603 3300pF 10% 50V X7R | AVX, 06035C332KAT2A |
| 9 | 1 | C22 | CAP, 0603 330pF 10% 50V X7R | AVX, 06035C331KAT2A |
| 10 | 2 | C23, C34 | CAP, 0603 1 μ F 20% 16V X7R | TDK, C1608X7R1C105M |
| 11 | 1 | C24 | CAP, 0603 22pF 10% 50V X7R | AVX, 06035C220KAT2A |
| 12 | 1 | C25 | CAP, 0603 2.2 μ F 10% 10V X5R | AVX, 0603ZD223KAT2A |
| 13 | 1 | C29 | CAP, 0603 100pF 5% 50V NPO | AVX, 06035A101JAT2A |
| 14 | 1 | D8 | DIODE, 12A, 100V SO-8 FL | ON SEMI, NTS12100EMFST1G |
| 15 | 1 | D12 | DIODE, Power DI-123 | DIODES, INC, DFSL1100-7 |
| 16 | 1 | L4 | IND, 2 μ H | COILCRAFT, SER2011-202L |
| 17 | 4 | Q11, Q12, Q13, Q14 | GaN TRANSISTOR | GaN SYSTEMS, GS61008P |
| 18 | 1 | RS2 | RES, 1.5m Ω 2512 | PANASONIC, ERJM1WTF1M5U |
| 19 | 2 | R43, R61 | RES, 0603 10 Ω 1% | VISHAY, CRCW060310R0FKEA |
| 20 | 1 | R44 | RES, 0603 2.2 Ω 5% | VISHAY, CRCW06032R20JNEA |
| 21 | 6 | R48, R55, R56, R68, R69, R70 | RES, 0603 0 Ω JUMPER | VISHAY, CRCW06030000Z0EA |
| 22 | 1 | R50 | RES, 0603 48.7k Ω 1% | VISHAY, CRCW060348K7FKEA |
| 23 | 1 | R57 | RES, 0603 140k Ω 5% | VISHAY, CRCW0603140KJNEA |
| 24 | 1 | R58 | RES, 0603 1M 5% | VISHAY, CRCW06031M00JNEA |
| 25 | 1 | R60 | RES, 0603 10k Ω 1% | VISHAY, CRCW060310K0FKEA |
| 26 | 1 | R64 | RES, 0603 10k Ω 1% | VISHAY, CRCW060310K0FKEA |
| 27 | 1 | R67 | RES, 0603 34k Ω 1% | VISHAY, CRCW060334K0FKEA |
| 28 | 1 | R71 | RES, 0603 237 Ω 1% | VISHAY, CRCW0603237RFKEA |
| 29 | 2 | R73, R86 | RES, 0603 100k Ω 5% | VISHAY, CRCW0603100KJNEA |
| 30 | 1 | R85 | RES, 0603 1k Ω 1% | VISHAY, CRCW06031K00FKEA |
| 31 | 1 | R87 | RES, 0603 1 Ω 5% | VISHAY, CRCW06031R00JNEA |
| 32 | 1 | U3 | IC, LTC7800EUD | LINEAR TECH, LTC7800EUDC#PBF |

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PARTS LIST

| ITEM | QTY | REFERENCE | PART DESCRIPTION | MANUFACTURER/PART NUMBER |
|---|-----|---------------------------|--------------------------------|-----------------------------------|
| Additional Demo Board Circuit Components | | | | |
| 1 | 0 | COUT11, COUT15 | OPTIONAL 7343 | |
| 2 | 0 | C27, C33 | OPTIONAL 0603 | |
| 3 | 0 | D9, D10 | OPTIONAL SOD1608 | |
| 4 | 0 | D11 | OPTIONAL CD0603-1005 | |
| 5 | 0 | R47, R65, R74, R88, R139 | OPTIONAL 0603 | |
| Hardware: For Demo Board Only | | | | |
| 1 | 1 | E13 TO E16, E18, E26, E50 | TESTPOINT, TURRET, 0.095" | MILL-MAX, 2501-2-00-80-00-00-07-0 |
| 2 | 1 | JP7 | HEADER, 3 PIN 0.079 SINGLE ROW | SULLINS, NRPN031PAEN-RC |
| 3 | 1 | JP13 | 2MM DOUBLE ROW HEADER, 3X2 | SAMTEC, TMM-103-02-L-D |
| 4 | 4 | J5 TO J8 | STUD, TESTPIN | PEM KFH-032-10 |
| 5 | 8 | J5 TO J8 X2 | NUT, BRASS 10-32 | ANY #10-32 |
| 6 | 4 | J5 TO J8 | RING, LUG #10 | KEYSTONE (8205) |
| 7 | 4 | J5 TO J8 | WASHER, TIN PLATED BRASS | ANY #10 EXT BZ TN |
| 8 | 1 | XJP13+2mm CTRS | SHUNT, 2mm | SAMTEC, 2SN-BK-G |
| 9 | 4 | | STAND-OFF, NYLON 0.50" TALL | KEYSTONE, 8833 (SNAP ON) |

SCHEMATIC DIAGRAM





ESD Caution

ESD (electrostatic discharge) sensitive device. Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjected to high energy ESD. Therefore, proper ESD precautions should be taken to avoid performance degradation or loss of functionality.

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